[0010] In order to provide a set of surface acoustic waves which propagate across a broad region of the substrate in parallel, an acoustically reflective grating having elements set at 45° to the axis of the beam is disposed along its path, each element reflecting portions of the wave at right angles to the axis of propagation. The acoustic waves are then collected, while maintaining the time dispersion information which characterizes the axial position from which an attenuated wave originated. The position of a touch in the active area is thus determined by, e.g., providing another reflective grating opposite the first, which directs the surface acoustic waves as a superposed wave to another transducer along an antiparallel path, recording the time of arrival and amplitude of a wave pattern, an attenuation of which corresponds to a touch and a characteristic time corresponding to a position along the axis of the arrays. The touch, in this case, may include a finger or stylus pressing against the surface directly or indirectly through a cover sheet. See, e.g., U.S. Pat. No. 5,451,723. In addition, if the emitted wave diverges, one of the reflective arrays may be eliminated, as shown in **FIG. 3**, although a rectangular coordinate system is not provided. In the case shown in **FIG. 3**, the maximum path length is approximately the height plus the width. Acoustic touch position sensors are also known wherein a single transducer per axis is provided for emitting a surface acoustic wave, as shown in **FIG. 5**. In this case, the maximum path length is two times the sum of the height plus width.

[0011] The known reflective arrays are generally formed of a glass frit which is silk-screened onto a soda-lime glass sheet formed by a float process, and cured in an oven to form a chevron pattern of raised glass interruptions. These interruptions typically have heights or depths of order 1% of the acoustic wavelength, and therefore only partially reflect the acoustic energy.

[0012] Thus, with waves having surface energy, the reflecting arrays may be formed on the surface, and where wave energy is present on both sides of the substrate, these reflecting arrays may be formed on one or both sides of the substrate. Because the touch sensor is generally placed in front of a display device, and because the reflective array is generally optically visible, the reflective arrays are generally placed at the periphery of the substrate, outside of the active sensing area, and are hidden and protected under a bezel. The reflective elements of the reflective array each generally reflect of order 1% of the surface acoustic wave power, dissipating a small amount and allowing the remainder to pass along the axis of the array. Thus, array elements closer to the transmitting transducer will be subject to greater incident acoustic energy and will therefore reflect a greater amount of acoustic power. In order to provide equalized acoustic power at the receiving transducer, the spacing of the reflective elements may be decreased with increasing distance from the transmitting transducer, or the acoustic reflectivity of the reflective elements may be altered, allowing increased reflectivity with increasing distance from the transmitting transducer.

[0013] Adler, US Re. 33,151, relates to a touch-sensitive system for determining a position of a touch along an axis on a surface. A surface acoustic wave generator is coupled to a sheet-like substrate to generate a burst of waves, which are deflected into an active region of the system by an array of wave redirecting gratings. According to a disclosed example, surface acoustic waves traversing the active region are, in turn, redirected along an axis by gratings to a receiving transducer. A location of touch is determined by analyzing a selective attenuation of the received waveform in the time domain, each characteristic delay corresponding to a locus on the surface. The redirecting gratings are oriented at 45° to the axis of propagation, and spaced at integral multiples of the surface acoustic wave wavelength, with dropped elements to produce an approximately constant surface acoustic wave power density over the active area. The spacing between grates decreases with increasing distance along the axis of propagation from the transducer, with a minimum spacing of at least one wavelength of the transmitted wave. U.S. Pat. Nos. 5,329,070, 5,260,521, 5,234,148, 5,177,327, 5,162,618 and 5,072,427 propose specific examples of types of surface acoustic waves that may be used in the acoustic sensor system taught in the Adler patents.

[0014] Where a separate reflective array is provided to redirect acoustic waves toward the receiving transducer, these are also provided with an increasing acoustic reflectivity with increasing distance from the receiving transducer. This is to reduce signal loss with propagation of the signal toward the receiving transducer along the axis of the reflective array. Typically, array pairs are designed as mirror images of one another.

[0015] U.S. Pat. No. 4,642,423, to Adler, incorporated herein by reference, addresses pseudo-planarization techniques for rectangular touchscreen surfaces formed by small solid angle sections of a sphere. According to Adler, reflective elements are angled to excite waves along sections of great circles of the spherical surface which extrapolate to a common intersection point. This patent addresses the need for touchscreens that match the curvature of CRT faceplates, for which the radius of curvature is always large compared to the diagonal dimension of the faceplate. This patent teaches means to minimize the inherent differences between spherical geometry of a small portion of a sphere and the Cartesian plane, allowing use in conjunction with controllers that are designed for flat sensor geometry. The acoustic waves generated by the system of Adler are substantially orthogonal. Known embodiments of the Adler technology include 19 inch diagonal CRTs with a radius of curvature of 32 inches and 13 or 14 inch diagonal CRTs with a radius of curvature of 22.6 inches.

[0016] c. Two Dimensional Position Sensing

[0017] In order to receive information determinative of the coordinates of a touch, two acoustic waves, each propagating across the active region of the substrate along perpendicular axes are provided. Thus, the two axes are typically used in conjunction to recognize a valid touch, but may also be analyzed separately and non-interactively to sequentially determine a position along each of the two orthogonal coordinate axes. In these known systems, the coordinate axes of interest to the application are defined by the physical configuration of the sensor. Thus, sensor design is constrained by the requirements of the application's coordinate system.

[0018] In known systems, the system operates on the principle that a touch on the surface attenuates surface acoustic waves having a power density at the surface. An attenuation of a wave traveling across the substrate causes a corresponding attenuation of waves impinging on the